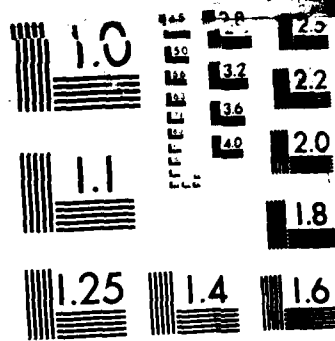


AD-A168 161 MILLIMETER-WAVE RANGE FOR THE QUICK EVALUATION OF LARGE 1/1
REFLECTOR ANTENNA. (U) AEROSPACE CORP EL SEGUNDO CA
S LAZAR ET AL. 01 APR 86 TR-0086(6925-06)-1 SD-TR-86-19
UNCLASSIFIED F04701-85-C-0086 F/G 14/2 NL





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

12

AD-A168 161

Millimeter-Wave Range for the Quick Evaluation of Large Reflector Antennas with Complex Feeds

S. LAZAR, H. B. DYSON, and A. LEONG
Electronics Research Laboratory
Laboratory Operations
Lockheed-Palco Corporation
Ft. Collins, CO 90521

1 April 1986

APPROVED FOR PUBLIC RELEASE
DISTRIBUTION UNLIMITED

STANDARD
MAY 1986

AD-A168 161

Prepared for
SPACE DIVISION
AIR FORCE SYSTEMS COMMAND
Los Angeles Air Force Station
P.O. Box 92900, Worldway Postal Center
Los Angeles, CA 90009-2900

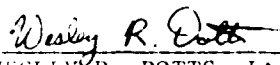
AD-A168 161

This report was submitted by The Aerospace Corporation, El Segundo, CA 90245, under Contract No. F04701-85-C-0086 with the Space Division, P.O. Box 92960, Worldway Postal Center, Los Angeles, CA 90009-2960. It was reviewed and approved for The Aerospace Corporation by M. J. Daugherty, Director, Electronics Research Laboratory.

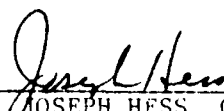
Lt Wesley R. Dotts, SD/CGX, was the project officer for the Mission-Oriented Investigation and Experimentation (MOIE) Program.

This report has been reviewed by the Public Affairs Office (PAS) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication. Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.



WESLEY R. DOTTS, Lt, USAF
MOIE Project Officer
SD/CGX



JOSEPH HESS, GM-15
Director, AFSTC West Coast Office
AFSTC/WCO OL-AB

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER TR-86-19	2. GOVT ACCESSION NO. ADA 168161	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) MILLIMETER-WAVE RANGE FOR THE QUICK EVALUATION OF LARGE REFLECTOR ANTENNAS WITH COMPLEX FEEDS		5. TYPE OF REPORT & PERIOD COVERED
		6. PERFORMING ORG. REPORT NUMBER TR-0086(6925-06)-1
7. AUTHOR(s) Steven Lazar, Howell B. Dyson, and Albert Leong		8. CONTRACT OR GRANT NUMBER(s) F04701-85-C-0086
9. PERFORMING ORGANIZATION NAME AND ADDRESS The Aerospace Corporation El Segundo, Calif. 90245		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Space Division Los Angeles Air Force Station Los Angeles, Calif. 90009-2960		12. REPORT DATE 1 April 1986
		13. NUMBER OF PAGES 13
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Antenna Pattern Synthesis Automated Range Antenna Radiation Patterns Compact Range Antennas Millimeter Wave Range		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) An automated millimeter-wave antenna range capable of measuring primary-feed structure patterns and transferring this data to a mainframe computer for secondary pattern computation is described. Its applicability to the rapid evaluation of complex feed structures as used in a Cassegrain antenna is illustrated. An example of a reflector antenna analysis is compared to a measured pattern.		

CONTENTS

I.	INTRODUCTION.....	5
II.	DESCRIPTION.....	7
III.	EXPERIMENT.....	11
IV.	CONCLUSION.....	13
	REFERENCES.....	15

Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	



FIGURES

1.	Block Diagram of Bench-Top Millimeter-Wave Antenna Range.....	8
2.	Photograph of Range and Instrumentation.....	9
3.	Comparison of Measured Secondary Pattern and Pattern Computed with GTD Program.....	12

I. INTRODUCTION

Radiation patterns of large reflector antennas are often difficult to measure. Even scaled models measured at higher frequencies require large antenna ranges. An alternative method for obtaining reflector antenna patterns is the measurements of primary-feed patterns on a small indoor range and the determination of the secondary patterns by computation. This procedure is described for a Cassegrain reflector system.

The use of the bench-top range for reflector simulation was especially attractive when the effects of a series of small design changes in a complex feed structure on the radiation pattern were needed to be known quickly. For example, this procedure was used in the optimization of a feed structure for low sidelobe levels.

The system consists of the millimeter-wave range, data acquisition instruments and the computational elements. The experiment was performed and recorded using a desktop computer which transmitted the data to a mainframe computer for the reflector antenna simulation. Far-field patterns of the reflector antenna with selected feed structures were conducted on the full-size range to verify the technique, and the results compared favorably with the computed results.

II. DESCRIPTION

The millimeter-wave range was originally developed for quasi-optical millimeter-wave measurement.¹ As shown in Fig. 1, the transmitter consists of a fixed 38 GHz 100 mW Gunn diode oscillator with a precision attenuator placed after the source for gain calibration. The range consists of the feed structure supported on posts on a rotating stage. The mounts were designed to allow for rotation for E and H plane measurements. The posts rest on micrometer driven single axis stages which vary the horn-subreflector spacing and rotation axis relative to the feed structure's phase center. The typical range was 4 ft, and boresight was established using an alignment laser. The rotating stage was mounted on a stepper motor located on the optical rail. Absorber material surrounds the range setup (Fig. 2).

A direct detection system was used with a Schottky diode mixer as detector. The ferrite switch was driven at ~ 200 Hz to maximize detector response with minimum $1/f$ noise in the correlator. The detected signal, amplified and level shifted using the correlator, was digitized in the data acquisition system. The computer integration of the signal allowed for adaptive averaging to reduce measurement time near the pattern maxima; measurement times were increased in the pattern minima region. The digitized patterns were stored in the desktop computer.

The desktop computer performed averaging and plotting of the measured feed pattern in real time. In addition, the patterns in 1° or $1/2^\circ$ steps were stored on floppy disk. The patterns chosen for further analysis were uploaded to the mainframe computer for analysis by the Geometrical Theory of Diffraction (GTD) program.² The GTD program computes the main-reflector antenna pattern with the measured primary-feed illumination and outputs the listings and plots of the Cassegrain antenna pattern.

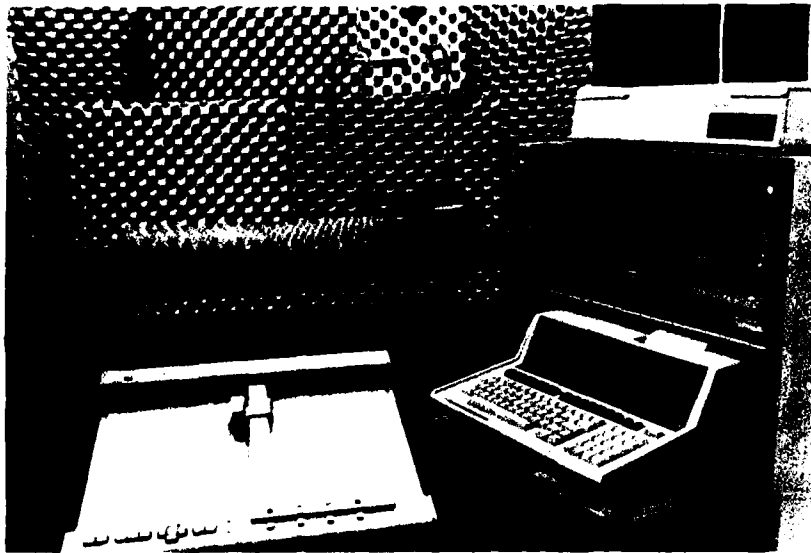


Fig. 2. Photograph of Range and Instrumentation

III. EXPERIMENT

The millimeter-wave antenna range was used to measure the effects of numerous modified horn and subreflector combinations as described in Ref. 3. This information was used as a first round analysis to find potentially suitable feed structures to illuminate the reflector. The feed structures found to be most likely to produce acceptable secondary patterns were transmitted from the desktop computer to the mainframe computer.

A reflector antenna with the selected feed structures was measured on the full size far-field antenna range, using a receiver with a 90-95 dB dynamic range.³ A measured far-field pattern superimposed on a pattern computed by the GTD program using primary-feed data measured on the millimeter-wave range is shown in Fig. 3. There is good agreement between the two patterns in the main lobe and in the average level for angles out to 80°. The greatest discrepancies are in the back lobes. This may be caused by the difference between the mathematical and physical model of the edge of the reflector, namely a knife-edge model in the simulation vs. the actual rounded edge of the dish. In addition, the receiver, which was used in the dish pattern measurement, was mounted on the back of the reflector and was not accounted for in the analysis.

IV. CONCLUSION

The millimeter-wave range was used to quickly eliminate poor horn-subreflector combinations without having to measure the secondary reflector patterns. The true capability of the system was exercised when the millimeter-wave range data was used in conjunction with the GTD reflector program to reduce measurement time and allow quicker modification and analysis turnaround time. Furthermore, with improved correlation between simulated and measured reflector patterns, secondary antenna pattern determinations may in some cases be performed solely by simulation of the reflector with measured primary feed-structure patterns.

REFERENCES

1. F. I. Shimabukuro, S. Lazar, M. R. Chernick, and H. B. Dyson, "A Quasi-Optical Method for Measuring the Complex Dielectric Constant of Materials," IEEE Trans. Microwave Theory & Tech., Vol. MTT-32, pp. 659-665, July 1984.
2. S. H. Lee, R. C. Rudduck, C. A. Klein, and R. G. Kouyoumjian, "A GTD Analysis of the Circular Reflector Antenna Including Feed and Strut Scatter," Ohio State University, Electrical Engineering Dept. TR-4381-1, May 25, 1977.
3. H. E. King, S. Lazar, R. B. Dybdal, D. S. Chang, H. B. Dyson, W. S. Wales, and W. C. Wysock, "Cassegrain Reflector Sidelobe Reduction Study," The Aerospace Corporation, Electronics Research Laboratory, TR-84A (5409-73)-1 (SD TR-85-39), 15 July 1985.

☆U.S. GOVERNMENT PRINTING OFFICE: 1986-678-004/30426

LABORATORY OPERATIONS

The Aerospace Corporation functions as an "architect-engineer" for national security projects, specializing in advanced military space systems. Providing research support, the corporation's Laboratory Operations conducts experimental and theoretical investigations that focus on the application of scientific and technical advances to such systems. Vital to the success of these investigations is the technical staff's wide-ranging expertise and its ability to stay current with new developments. This expertise is enhanced by a research program aimed at dealing with the many problems associated with rapidly evolving space systems. Contributing their capabilities to the research effort are these individual laboratories:

Aerophysics Laboratory: Launch vehicle and reentry fluid mechanics, heat transfer and flight dynamics; chemical and electric propulsion, propellant chemistry, chemical dynamics, environmental chemistry, trace detection; spacecraft structural mechanics, contamination, thermal and structural control; high temperature thermomechanics, gas kinetics and radiation; cw and pulsed chemical and excimer laser development including chemical kinetics, spectroscopy, optical resonators, beam control, atmospheric propagation, laser effects and countermeasures.

Chemistry and Physics Laboratory: Atmospheric chemical reactions, atmospheric optics, light scattering, state-specific chemical reactions and radiative signatures of missile plumes, sensor out-of-field-of-view rejection, applied laser spectroscopy, laser chemistry, laser optoelectronics, solar cell physics, battery electrochemistry, space vacuum and radiation effects on materials, lubrication and surface phenomena, thermionic emission, photo-sensitive materials and detectors, atomic frequency standards, and environmental chemistry.

Computer Science Laboratory: Program verification, program translation, performance-sensitive system design, distributed architectures for spaceborne computers, fault-tolerant computer systems, artificial intelligence, micro-electronics applications, communication protocols, and computer security.

Electronics Research Laboratory: Microelectronics, solid-state device physics, compound semiconductors, radiation hardening; electro-optics, quantum electronics, solid-state lasers, optical propagation and communications; microwave semiconductor devices, microwave/millimeter wave measurements, diagnostics and radiometry, microwave/millimeter wave thermionic devices; atomic time and frequency standards; antennas, rf systems, electromagnetic propagation phenomena, space communication systems.

Materials Sciences Laboratory: Development of new materials: metals, alloys, ceramics, polymers and their composites, and new forms of carbon; non-destructive evaluation, component failure analysis and reliability; fracture mechanics and stress corrosion; analysis and evaluation of materials at cryogenic and elevated temperatures as well as in space and enemy-induced environments.

Space Sciences Laboratory: Magnetospheric, auroral and cosmic ray physics, wave-particle interactions, magnetospheric plasma waves; atmospheric and ionospheric physics, density and composition of the upper atmosphere, remote sensing using atmospheric radiation; solar physics, infrared astronomy, infrared signature analysis; effects of solar activity, magnetic storms and nuclear explosions on the earth's atmosphere, ionosphere and magnetosphere; effects of electromagnetic and particulate radiations on space systems; space instrumentation.

END
DTIC

7-86